Early Mars (P12)

N94-24997

Room 102 Mon PM
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198314
p. 1

P12-02 1344H INVITED

The Geophysical Signal of the Martian Global Dichotomy

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A first-order tectonic question for Mars is the origin and nature of the global dichotomy (GD) separating approximately the northern and southern hemispheres of the planet. It is appropriate to focus on hypotheses for the origin of the GD as well as on geophysical models of related internal structure that are constrained by present-day observations.

There are basic planetary scale observations that relate to the GD: (i) The dichotomy boundary separates two fundamentally different elevations on the planet, as the terrain to the north is lower by an average of about 3 km. (ii) The boundary separates terrain of regionally distinct crater ages, heavily cratered (older) in the south and sparsely cratered (younger) in the north. (iii) The amount of ancient crust apparently removed from north of the dichotomy boundary cannot be accounted for by simple surface erosion and deposition in the south, and the constraint becomes particularly severe if isostatic adjustment is presumed to have accompanied this process. This last point leads to the supposition that some type of interior process must have been responsible for the creation of the GD.

An obvious way to create the observed elevation difference between the two hemispheres is with a thinner crust in the north, although a denser crust would also work. Hypotheses for producing a thinner northern crust include preferential sub-crustal erosion, a giant impact, and simply invoking the crustal thickness difference as a primordial feature of the planet.

If the GD represents a fundamental change in the crustal thickness of Mars, then there should be geophysical evidence of this. The center-of-figure to center-of-mass offset of the planet may be related to the GD, but the Tharsis topography must certainly also contribute. If the Tharsis and GD effects can be separated, then a crustal thickness model can be tested, though the results will not be unique.

The gravity field provides another geophysical constraint on GD models. A simple change in thickness of an isostatically compensated crust should show a characteristic gravity signal across the dichotomy boundary. There *is* a gravity anomaly that is clearly associated with the boundary in regions where the gravity signal is not cluttered by contributions from other features such as Tharsis and Elysium. The gravity signal has a complex spatial relationship with the boundary, and efforts are presently underway to model this anomaly.